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Canada. EPS. WPCD.

EPS 3-WP-78-7

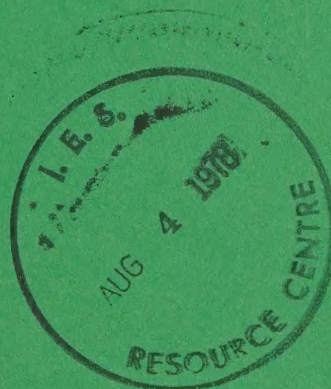
WASTEWATER GENERATION AND DISPOSAL IN VENEER AND PLYWOOD
PLANTS IN BRITISH COLUMBIA, 1978.

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Wastewater Generation and Disposal in Veneer and Plywood Plants in British Columbia



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Water Pollution Control Directorate
June 1978

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WASTEWATER GENERATION AND DISPOSAL

IN VENEER AND PLYWOOD

PLANTS IN BRITISH COLUMBIA

by

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Report No. EPS 3-WP-78-7
June 1978

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Cat. No. En43-3/78-7

ISBN 0-662-02083-9

ABSTRACT

This investigation was carried out to characterize the wastewater from British Columbia plywood and veneer plants; to examine in plant operations that generate wastewater; and to document wastewater disposal and treatment procedures that are being used within the industry.

The data obtained indicate that all wastewater generated by the plywood and veneer operations is toxic to fish at low effluent concentrations and that this toxicity increases with increased resin acid and phenolic content of the effluent.

RÉSUMÉ

La présente étude visait à caractériser les eaux résiduaires des usines de placage et de contreplaqué de la Colombie-Britannique; à examiner, sur place, les opérations qui en produisent et à établir une bibliographie des procédés de traitement et d'évacuation actuellement employés dans cette industrie.

D'après les données recueillies, à faible concentration, toutes les eaux résiduaires des opérations de placage et de fabrication de contreplaqué sont toxiques pour le poisson; leur toxicité augmente proportionnellement à la concentration des acides résiniques et des phénols.

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LIST OF ABBREVIATIONS

BOD ₅	five-day biochemical oxygen demand
TR	total residue
NFR	non-filterable residue
TOC	total organic carbon
COD	chemical oxygen demand
96-hr LC ₅₀	96-hour bioassay test (lethal concentration)
CuSO ₄	copper sulphate
H ₃ PO ₄	phosphoric acid
H ₂ SO ₄	sulphuric acid
EDTA	disodium ethylene diamine tetra acetate
MBTH	3-methyl-2-benzylthiazalinone hydrazone hydrochloride
conc	concentrated
dil	dilute
nm	nanometre
cc	cubic centimetre
mg/L	milligrams/litre
°C	degrees Celsius
°F	degrees Fahrenheit
gal	gallon
hr	hour
wk	week
yr	year
GF/C	glass filter type C
IBC	International Biophysics Corporation
UV-Vis	ultraviolet - visual
N/A	not available

CONCLUSIONS

1. The data obtained indicates that all the wastewater generated by the veneer and plywood production industry is toxic to fish at low effluent concentrations.
2. The data shows that the acute toxicity of the effluent increases with increased resin acid and phenolics concentrations.
3. Of 17 conditioning operations surveyed, two discharged conditioning water to natural water courses, while eight operations discharged conditioning water to ground. Six operations had no positive discharge of conditioning water and one discharged to a municipal sewer.
4. Of the 20 plants surveyed that incorporated drying in their production line, eight discharged dryer clean-up water to natural water courses, six discharged to lagoons, five discharged to municipal sewers and one reused the clean-up water as glue makeup water.
5. All but one of the plants carrying out drying operations also carried out glueing operations. Only two of the plants operating glue spreading facilities discharged the glue spreader wash water. All others practiced total recycle of glue spreader wash water.
6. Wastewater produced from veneer and plywood operations, with the possible exception of log storage and fluming operations, can be totally recycled for prolonged periods of time.
7. The conditioning operation, at plants not practicing conditioning water recycle, generates the largest daily volume of wastewater being discharged. This wastewater can be sprayed into burners or evaporated rather than discharged.

1 INTRODUCTION

There are approximately 35 veneer and/or plywood manufacturing plants in British Columbia. This report concerns 27 of these plants that were examined during the period January - March, 1977.

The objectives of this study were:

- (a) to characterize the wastewater produced in veneer and plywood manufacturing operations,
- (b) to review the in-plant operations as they relate to wastewater generation,
- (c) to document the present treatment and wastewater disposal techniques being used within the industry.

This study examined the wastewater generated by log conditioning, dryer and glue spreader clean-up and dryer fire controls. A brief look at log storage and fluming wastewater is also included.

2 PLANT OPERATIONS

Most of the veneer and plywood plants in B.C. operate year round with occasional shutdowns at some plants for overhauls, repairs or modifications.

The amount and type of wood utilized varies considerably from plant to plant, as indicated in Table 1, General Plant Statistics.

2.1 Production Operations

A flow sheet showing the general production line in a plant manufacturing both veneer and plywood is presented in Figure 1. Not all plants follow this general procedure. Some plants manufacture only green (undried) veneer. One plant produces both green and dried veneer. The veneer from these plants is sold to plywood manufacturing plants which cannot produce enough veneer to fully supply their own plywood production requirements.

2.1.1 Log debarking operations

The production line begins with the cutting of the logs into 8-1/2 foot (2.6 metre) sections called blocks. Following this, the bark is removed. None of the plants considered in this report used wet debarking methods. No significant amount of wastewater originates from the dry debarking operations. In some plants, the logs are debarked first and then cut into blocks. After cutting and debarking the blocks are transported to the conditioning chests.

2.1.2 Conditioning operations

Conditioning of the blocks serves to soften, moisten and thaw the wood to prevent cracking and chipping of the wood on the lathe. The conditioning also removes loosely adhering dirt and bark.

All the veneer operations in the interior region of B.C. carry out conditioning prior to peeling. At present none of the veneer operations in the Lower Mainland or on Vancouver Island carry out conditioning; however, several plant managers stated that their companies planned to install conditioning facilities in the next two years.

TABLE 1. GENERAL PLANT STATISTICS

Plant	Products	# Operating Days/year	Species and % of Total	Volume of Wood in Cunits
1	Veneer-Plywood	200	95% Fir, 5% Spruce	90
2	Veneer-Plywood	250	60% Spruce, 40% Fir	200
3	Veneer-Plywood	245	80% Spruce-Balsam, 20% Fir	165
4	Veneer-Plywood	250	78% Spruce-Pine-Hemlock-Balsam, 22% Fir	450
5	Green Veneer	240	90% Spruce-Balsam-Pine, 10% Fir-Larch	200
6	Veneer-Plywood	N/A	65% Pine, 25% Spruce-Balsam, 10% Fir	N/A
7	Green Veneer	220	45% Spruce, 40% Balsam, 15% Fir-Larch	200
8	Green Veneer	230	70% Fir, 30% Spruce	100
9	Veneer-Plywood	200	80% Spruce, 10% Pine, 10% Fir Larch	80
10	Green Veneer	250	- 70% Spruce, 25% Fir, 5% Balsam	300
11	Veneer-Plywood	240	85% Spruce, 8% Hemlock - Balsam, 7% Fir	95
12	Green Veneer	250	85% Spruce, 6% Fir, 9% Balsam-Pine	360
13	Veneer-Plywood	250	60% Spruce, 40% Pine	140
14	Veneer-Plywood	240	62% Spruce, 30% Fir, 8% Pine - Balsam	600
15	Veneer-Plywood	240	90% Spruce-Fir, 10% Pine	400
16	Green Veneer	250	56% Pine, 22% Fir, 22% Spruce	400
17	Veneer-Plywood	240	50% Spruce, 50% Fir	300
18	Green and Dry Veneer	250	60% Fir, 40% Balsam	180
19	Veneer-Plywood	250	80% Fir, 20% Balsam	200
20	Veneer-Plywood	210	65% Fir, 15% Hemlock-Balsam, 20% Cedar-Pine	150
21	Veneer-Plywood	240	70% Fir, 30% Balsam	450-500
22	Veneer-Plywood	235	65% Fir, 20% Balsam, 15% Hemlock	600
23	Veneer-Plywood	252	50% Fir, 50% Balsam	160
24	Veneer-Plywood	240	70% Fir, 30% Spruce	
25	Veneer-Plywood	240	60% Fir, 32% Spruce, 8% Balsam	520
26	Veneer-Plywood	250	80% Spruce, 20% Fir	N/A
27	Veneer-Plywood	250	65% Fir, 30% Hemlock, 5% Spruce	320

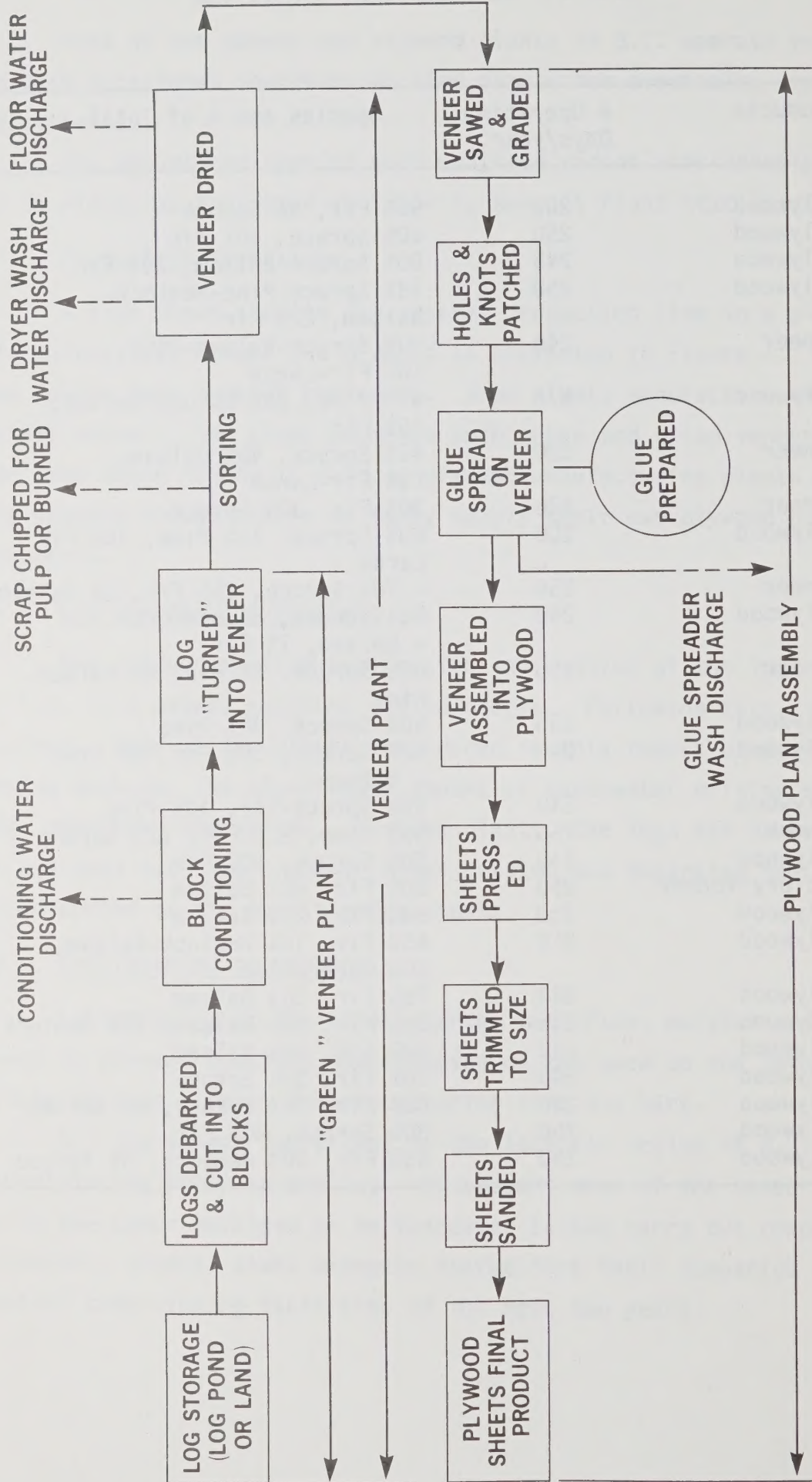


FIGURE 1 VENEER PLYWOOD PLANT FLOW DIAGRAM

Conditioning is generally carried out by one of two methods; steam or hot water spray. The conditioning vats or chests are usually constructed of cement blocks and are approximately 100 to 200 feet long, 12 feet high and 10 feet wide. If steam is used, perforated parallel steam pipes are installed on the floor along the full length of the chest. If hot water is used, the pipes are laid out similarly on the ceiling. One plant uses both steam and hot water spray for conditioning.

The chests usually have only one entrance which is covered with a flap of canvas or an insulated sliding door. The blocks are loaded into the chests with fork lifts. When the chests are full, steam or water at approximately 65°C (150°F) is turned on and allowed to condition the blocks. When conditioning is complete the blocks are unloaded and transported to the lathe.

The time the blocks remain in the conditioning chests varies considerably depending on the climatic conditions, the condition, size and species of wood, the type and efficiency of the conditioning chests and the production demand of the plywood plants. Ideally, the blocks should be conditioned about eight hours in the summer and up to 36 hours in the winter but, because of production demands, the range is actually around four to 24 hours at some plants in the winter and less in summer.

There are some variations to the general conditioning procedure, with the most significant being a hot water immersion system used in one plant. This system was installed about two years ago. It consists of three tanks, each approximately 75 feet (22.8 m) long, nine feet (2.7 m) wide and six feet (1.8 m) deep. Two of these tanks are used for conditioning and the third acts as a recycle sump. The tanks are filled with water which is maintained at approximately 50°C (120°F) and is continuously recycled. The blocks are continuously fed into the tanks at one end and emerge at the other end 6-1/2 to 8 hours later. Except for the small opening at each end, the tanks are enclosed. The only chemical added to the recycle water is soda ash which is used to control the pH. The wood chips and other debris are continuously removed by scrapers. The water is never drained but new water is added to make up for losses from evaporation and absorption.

This system has several advantages over the more conventional conditioning system in use, such as:

- a) there is no wastewater discharge,
- b) there is less heat loss since the system is enclosed,
- c) there is less time required in loading and unloading operations,
- d) there is no shut down of conditioning during loading and unloading operations.

2.1.3 Peeling and sorting operations

After conditioning, the blocks are peeled on a lathe. In some plants miscible oil is used as a lubricant on the lathe. In other plants only water is used. The volume of wastewater, in either case, is insignificant. The veneer is peeled in various thicknesses and then sorted. The discarded material is either burned or made into chips for pulp. The acceptable veneer is either sold or dried, if the plant is equipped for this operation.

2.1.4 Drying operations

For the layers of veneer to adhere properly after glueing and pressing the moisture content in the wood should not exceed 2%. Several types of dryers are in use but all are of the same basic design. The dryers are constructed in sections that are joined together longitudinally. The walls of each section are doors that can be opened to allow access to the inside of the dryer for cleaning.

The veneer is transported through the dryer on powered roller lines which are mounted in several levels or decks. The number of decks varies from four to eight from one plant to another. The size of the dryer is usually expressed in terms of the number of deck-sections.

Air at approximately 170°C - 200°C (340°F - 390°F) is circulated through the dryer either longitudinally or transversely. In some plants, a new type of jet dryer in which hot air is forced through jets located just above the veneer rather than by open circulation is used. The heat is supplied by either steam or natural gas burners and large blowers are used to circulate the hot air.

The veneer passes through the dryer in 8 - 25 minutes depending upon the condition, species and thickness of wood and the temperature of the dryer.

During the drying process some of the volatile resins are vaporized. This vapor is usually emitted to the air through exhaust stacks but some of it condenses on the cooler portions of the dryer such as the floor, walls or any point where there is an outside air leak. The pitch formed can be ignited by a spark or high dryer temperature at or above the ignition point of the pitch. The floors in some dryers are kept wet with a thin layer of water to control the rate of water loss from the veneer and to lessen the risk of fire. Most dryers have a built-in deluge system to extinguish any fires that occur. The dryers are generally cleaned once a week, usually on weekends, to remove any pitch buildup.

2.1.5 Plywood assembly operations

After drying, the veneer is graded and holes and imperfections are filled or patched. The veneer is then cut to the approximate dimensions, glue is spread on the veneer surface and the veneer is stacked to the desired thickness. The stacked and glued veneer is then pressed in a hot press at approximately 130°C to 145°C (270°F to 290°F) to form the plywood which is sanded, trimmed, and stored, or shipped.

2.2 Clean-up Operations

The dryers and glue spreaders are the only areas where a significant amount of wastewater is generated during clean-up operations. Most other clean-up operations carried out inside the plant are done without water. The sawdust and scrap wood are swept off the floor and compressed air is used to blow sawdust off or out of equipment.

2.2.1 Dryer clean-up operations

The dryers are generally cleaned once a week, on weekends. First they are dry cleaned with brooms, compressed air and scrapers, and then a strong caustic detergent is sprayed onto the areas to be cleaned. There are several different brands of caustic spray and all are considered to be highly toxic to fish in undiluted form. The detergent contains a foaming agent that adheres to the surface to be cleaned. The caustic foam is left on the surface for 20 - 30 minutes prior to rinsing with water from fire hoses. Only one plant used water without detergent to clean its dryers.

The volume of detergent is very small compared to the volume of rinse water used. The amount of wastewater produced during the dryer clean-up operation is probably 1000 - 10,000 gallons per dryer per clean-up although no accurate measures of volumes are available. The volume of water used to clean the dryer would depend on the condition and type of wood being dried, the temperature of the dryer and the actions of the clean-up man controlling the rinse hose.

2.2.2 Glue spreader clean-up operations

The glue spreaders are cleaned at least once a day and, frequently, after every shift. The spreading equipment is simply rinsed off with water. No detergents or other cleaning chemicals are used. In all but one plant studied, glue spreader wash water was recycled completely and used to make up more glue. One other plant occasionally dumped the glue wash recycle holding tank to the ground to facilitate cleaning of the sump.

3 METHODS AND MATERIALS

3.1 Sampling

Grab samples were collected for all analyses. The collected samples were placed in the appropriately sized glass or plastic container and preserved immediately, as outlined in the Environment Canada Sampling Handbook [1]. Table 2 describes the size and type of container used and the preservation technique employed for each analysis performed on the samples. The parameters examined were: pH, BOD₅, TR, NFR, TOC, COD, phenolics, resin acids and 96-hr LC₅₀.

At the end of each sampling day the samples for chemical analysis and bioassay determinations were transported to the appropriate Environment Canada laboratory facility. The samples were transported by the most expedient means available, usually air express. At no time did the period between sample collection and delivery to the laboratory exceed 48 hours. Analytical determinations were carried out as outlined in the Environment Canada Laboratory Manual [2].

3.1.1 Conditioning water

A sample was obtained from the conditioning water system from each of 17 plants. In cases where the conditioning water was being recycled the sample was obtained from the recycle storage tanks. The samples obtained from plants where the conditioning water was used only once and discharged were all collected from the discharge line prior to wastewater treatment.

3.1.2 Dryer wash water

Samples of dryer wash water were collected from six plants during the detergent rinse operations. The samples were usually obtained from the open floor drains which run along the outside length of the dryer.

3.1.3 Glue spreader wash water

Samples of glue spreader wash water were collected from two plants; one which regularly discharged the glue spreader wash water, and one which occasionally discharged the contents of the glue wash water holding tank.

TABLE 2. SAMPLE CONTAINERS AND PRESERVATION METHODS

Parameter	Type of Container	Preservation
pH BOD ₅	1000 cc wide-mouth hard plastic bottle	temperature maintained at approximately 4°C
Residues - TR - NFR	1000 cc wide-mouth hard plastic bottle	same as above
TOC	500 cc narrow-mouth hard plastic bottle	same as above
COD	100 cc wide-mouth glass bottle	2 drops conc. H ₂ SO ₄
Phenolics	1000 cc wide-mouth glass bottle with aluminum foil washers in lid	acidified to pH 4 with dilute H ₃ PO ₄ then 20 cc of 10% CuSO ₄ added.
Resin Acids	same as above	none
96-hr LC ₅₀	Four 5-gallon hard plastic jerry cans	temperature maintained at approximately 4°C

3.1.4 Dryer floor water and log flume water

Samples of dryer floor water and log flume water were collected from one plant. Since no fires were encountered during the study, a sample of dryer deluge water could not be obtained.

3.2 Analysis

An explanation and a brief description of the laboratory analysis procedure for each of the parameters noted in Table 2 follows. A more detailed description of the analysis methods is available in the Environment Canada Laboratory Manual [2].

- (a) pH is a measure of the H^+ ion concentration. The pH scale is a series of numbers which express the acidic or basic properties of a solution. Numbers above seven indicate increasing basic condition with increasing numerical value. Numbers below seven indicate increasing acidic conditions with decreasing numerical value. pH 7 is neutral.

All pH values quoted in this report where the results of measurements taken with a Fisher 401 Accumet pH meter with a precision of ± 0.02 pH units under normal operating conditions.

- (b) The five-day biochemical oxygen demand (BOD_5) determination measures the quantity of oxygen required for the stabilization of organic matter by microorganisms with a period of five days at a temperature of $20^{\circ}C$.

The BOD_5 test gives an indication of the amount of oxygen that will be consumed during the decomposition of the bio-degradable portion of the sample.

The sample to be analyzed was first neutralized to a pH range of 6 to 8.5. Any known toxins in the sample were also neutralized and then at least three different dilutions were prepared. The dilution water was treated with buffer solutions prior to the test. An initial dissolved oxygen concentration reading was taken on each sample using an IBC 500-051 Dissolved Oxygen Meter and the

samples were then incubated at 20°C for five days. At the end of the five-day period, the dissolved oxygen concentration was again measured and the approximate oxygen demand was calculated and reported as the BOD₅ expressed in mg/L. In cases where the results were given as a range, the average value was reported. The minimum detectable concentration is 2 mg/L. The precision of this test has not been assessed.

- (c) Total residue refers to the material left in an evaporating dish after the evaporation of the sample.

100 cc of the sample were placed in a dried pre-weighed evaporating dish and evaporated at 90°C. The residue was then heated to 103°C for one hour. The dish was cooled, brought to constant weight and weighed. The increase in weight was used to calculate the TR concentration in the sample which was reported as mg/L.

The minimum detectable concentration is 10 mg/L. The precision of this test is approximately ±5%.

- (d) Non-filterable residue (NFR) is that portion of the total residue retained by a specific filter. NFR is also referred to as a suspended matter or suspended solids.

The sample was filtered through a pre-weighed Gooch crucible containing a GF/C filter paper. The crucible was dried at 103°C, cooled, brought to constant weight, and re-weighed. The increased weight was used to calculate the NFR and the results were reported as mg/L.

The minimum detectable concentration is 10 mg/L. No estimate of the precision of the test is available at the time of writing this report.

- (e) Total organic carbon determination measures the organic carbon concentration of the sample. The TOC results, when compared with the BOD₅ results for wastewater, give valuable information concerning the characteristics of the organic constituents in the sample.

A Beckman Total Carbon Analyzer Model 915 was used for TOC determinations. For these determinations, the procedure as outlined by the manufacturer for the model 915 analyzer was followed.

The results are reported as mg/L TOC. The minimum detectable concentration is 1 mg/L and the precision is $\pm 1\%$ to 2%.

- (f) Chemical oxygen demand is an estimate of that portion of the sample which is susceptible to oxidation by a strong chemical oxidant. The sample was refluxed in a 50% sulphuric acid solution with potassium dichromate as the oxidizing agent. Mercuric sulphate and silver sulphate were added as catalysts. The excess potassium dichromate was titrated with ferrous ammonium sulphate and the COD was calculated and expressed as mg/L COD.

The minimum detectable concentration is 20 mg/L and the precision is 14 mg/L on a 1000 mg/L COD sample.

- (g) Phenolics are defined as any hydroxyl derivatives of benzene or its homologue. Phenolics are found in the wastewater from many industrial processes, including the distillation of wood products. They are known to be toxic to fish at concentrations below 1 mg/L and may also cause flavour deterioration in fish [3].

200 cc of the sample was placed in a one-litre distilling flask with 20 cc of distilled water and distilled until 200 cc of distillate were collected. The distillate was treated with EDTA and MBTH solutions and the absorbance was compared with known standards at 490 nm using a UV-VIS Beckman Acta C-III Spectrophotometer. The results are expressed as mg/L phenolics.

The minimum detectable concentration is 0.22 mg/L and the precision of the test is estimated to be $\pm 10\%$.

- (h) Resin acids are diterpenes containing 20 carbon atoms per molecule. They are formed in nature by oxidation and polymerization of terpenes.

Resin acids are found in pulp mill and log conditioning effluents. They are known to be toxic to fish at concentrations as low as 1 mg/L [3]. The sample was acidified to convert all resin acid salts to resin acids and the sample was then extracted with ether. The ether was evaporated and the residue containing the resin acids was redissolved in a known volume of methanol. The resin acid concentration was determined with a Hewlett-Packard 5830A gas chromatograph.

The minimum detectable concentration is 0.5 mg/L and the precision of the test is not presently known.

- (i) The static fish bioassay gives an approximate value of the biological toxicity of an effluent. It can be defined as the concentration or level of a measurable lethal agent required to kill 50 percent of a group of test organisms over 96 hours.

The bioassay test consisted of a series of 30-litre, all glass test vessels containing different sample dilutions. The test vessels were placed into a controlled environment room where the temperature was maintained at $13^{\circ} \pm 1^{\circ}\text{C}$ and the photo period was limited to 16 hours per 24 hours. The samples were continuously aerated throughout the 96-hour test period with oil-free compressed air. Eight to ten underyearling rainbow trout (Salmo gairdneri) were placed in each vessel. The fish-loading density in each test vessel did not exceed 0.60 grams of fish per litre of test water. The fish mortality versus sample dilution for each test vessel was plotted on a graph and a 96-hour LC_{50} was established [4].

The precision or the accuracy of this test cannot be assessed.

4 RESULTS AND DISCUSSION

4.1 Wastewater Characterization

Tables 3 to 7 in the appendix present the results of analysis of the samples collected from the various wastewater streams.

4.1.1 Conditioning water

The conditioning water was toxic to fish at very low concentrations. The tables noted above show a relationship between toxicity and resin acids, phenolics and total organic carbon. The pH in some of the samples was probably a contributing factor to the toxicity. The concentrations of biochemical and chemical oxygen demand, and total and non-filterable residue were generally high enough to have undesirable effects on natural water courses.

4.1.2 Dryer clean-up water

The dryer clean-up was also toxic to fish at low concentrations. There was not enough data to determine toxic constituents but there appeared to be some correlation between the concentrations of resin acids, phenolics, and toxicity. The presence of cleansing agents may also have had some bearing on the toxicity. The pH of the samples was higher than that of the conditioning water due to the presence of caustic clean-up solutions. The concentrations of biochemical and chemical oxygen demand and total and non-filterable residues were high enough to be detrimental to receiving waters.

4.1.3 Glue spreader wash water

The toxicity of the glue spreader wash water was probably due primarily to the phenolics present in the sample. The high pH probably contributed to the toxicity.

4.1.4 Dryer floor water and log flume water

The toxicity of the dryer floor water and flume water was probably due to the resin acids and phenolics present. The low pH may not directly cause toxicity, but the fish would be under greater stress and, therefore, more subject to the lethal effects of the other toxic constituents. Although the sample of log flume water was the least

toxic of all in this survey, it should be noted that the water would be in use for another three months before being discharged; this would likely increase the toxicity.

4.2 Wastewater Sources and Control

Table 8, in the appendix, outlines the sources of wastewater, the volumes of wastewater and the disposal methods employed at the plants examined in this study. Very little information was available on the volumes of some of the wastewater discharges, particularly dryer clean-up water and dryer floor water.

4.2.1 Conditioning water

The conditioning water, from plants using hot water to condition the logs, is recycled for at least one week and, in one instance, indefinitely. In most cases, when the recycled wastewater is discharged, it is released into some form of ground disposal. Two plants evaporated the water in large tanks and, either burned the sludge or disposed of it in a land fill site. One plant held the recycled conditioning water and pumped it to a burner once a week.

The steam conditioning water is continuously discharged and, therefore, steam conditioning generates more wastewater than does hot water conditioning on a daily basis. Two plants pumped the wastewater to burners. Two discharged the wastewater to holding lagoons for exfiltration and evaporation. One of these used two ponds in series and recycled some of the water from the second pond for other plant requirements. The other treated the water in a biological treatment system prior to discharge to the exfiltration lagoon. One plant discharged to a log storage pond which is separated from the adjacent river by a dyke. Probably, the pond water is exfiltrating into the river. The remaining plant discharged to a municipal sewer. One plant used both steam and hot water conditioning although steam was used very infrequently. When steam was used at this plant, the wastewater was discharged to an exfiltration lagoon.

4.2.2 Dryer clean-up water

The wastewater generated by dryer clean-up was recycled in some plants, but several plants still discharged directly to a natural

water course. Some of the plants located in urban areas are connected to the municipal sewer systems. Some plants use very little or no water to clean out the dryers. Properly operated and controlled dryers result in less pitch buildup inside and outside the dryers and, consequently, a lower volume of clean-up water.

4.2.3 Glue spreader wash water

Since this wastewater was recycled in all but one plant, very little need be said about this operation. No cleansing agents are used during the clean-up of the glue spreaders and the volume of water used is small in comparison to that for the dryer clean-up.

Although most plants recycled the glue spreader wash water, some glue spreader water, from at least one plant, was still released to the ground when the sludge in the recycle storage tanks was cleaned out. Some plants hire septic tank cleaning companies to pump out the storage tanks. However, no information was available on the final disposal site.

4.2.4 Dryer floor water and deluge water

Most plants with dryers use floor water in one or more of their dryers. The newer jet dryers apparently do not require it. The volume of this water is not known but probably does not exceed 300 gallons per day per dryer. It is usually discharged in the same manner as deluge water.

The deluge water is used only when there is a fire inside the dryer. The volume varies considerably, depending on the size of the dryer and the extent of the fire, but probably exceeds 5000 gallons when used in most plants. Deluge water is frequently recycled and is often stored in exfiltration ponds. Some plants discharge it to natural water courses.

4.2.5 Log flume and storage water

The contamination of natural water courses with the dissolved and suspended material produced by log storage or fluming has been a problem for some time and has been the subject of several reports, such as Pacific Northwest Pollution Control Council, "Log Storage and Rafting in Public Waters" (August 1971). There is little to add to those reports, except to note that, inevitably, phenolics and resin acids will be leached from logs stored in water.

REFERENCES

1. Environment Canada, Pacific Region, Pollution Sampling Handbook, Revised January 1976.
2. Environment Canada, Pacific Region, Laboratory Manual, Revised, to be published.
3. Water Quality Criteria, second edition, California State Water Resources Control Board, January 1973.
4. Bioassay Records, Bioassay Laboratory, Environmental Protection Service, Pacific Region.

ACKNOWLEDGEMENTS

I would like to thank the managers and staff of the veneer and plywood manufacturing plants studied in this report for their cooperation and assistance in providing technical information. I would also like to thank Mr. Satnam Sidhu of the Environmental Protection Service for his assistance in the field work carried out for this study and Dr. Bill Hancock of the Western Forest Products Laboratory for his technical advice and assistance.

This study was carried out under the general direction of Mr. G. Trasolini, Technical Officer, Environmental Protection Service, Pacific Region.

APPENDIX
TABLES OF ANALYTICAL RESULTS
AND
GENERAL WASTEWATER RELATED INFORMATION

TABLE 3. ANALYTICAL RESULTS FOR CONDITIONING WATER

Plant #	pH	BOD ₅ **	TR	NFR	TOC	COD	Phenolics	Resin Acids	96-hr LC ₅₀
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	%
1*	4.1	6450	8000	370	4890	15000	1.50	2.5	0.56
2	7.8	3800	3500	140	1160	3300	0.50	12	1.8
3	5.2	1600	3200	88	1400	4300	0.50	12	4.2
4*	4.9	1000	1500	40	770	4200	0.38	0.6	4.6
5	5.2	1700	3800	360	1700	5100	0.44	12	1.8
6	8.0	1550	19000	5000	7960	23000	5.40	31	0.2
7	5.0	1900	3000	56	1600	4400	0.84	4.6	1.8
8	6.3	1500	4000	500	2180	6800	0.88	58	0.85
9*	5.1	2300	3700	470	1930	5300	0.56	5.6	1.8
10	5.6	2000	4600	82	2160	5600	0.88	19	2.7
11	6.6	575	1000	88	504	1400	0.50	9.8	17
12	7.7	690	1800	140	824	2500	1.2	31	2.3
13*	8.2	1600	3900	96	1616	4400	0.3	0.9	18
14*	4.7	2300	3600	330	1978	6000	1.2	13	1.8
15	7.5	1400	4400	130	1880	5300	3.2	11	1.8
16*	8.4	380	1600	20	273	1200	0.38	30	1.8
17	5.0	4200	10600	600	4550	13000	1.6	46	0.67
Average	6.2	2350	4800	501	2198	6500	1.19	17.6	3.75

* Samples of non-recycled conditioning wastewater.

** Results reported as on average.

TABLE 4. ANALYTICAL RESULTS FOR DRYER WASHDOWN WATER

Plant #	pH	BOD ₅ *	TR	NFR	TOC	COD	Phenolics	Resin Acids	96-hr LC ₅₀
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	%
1	7.0	450	1400	870	430	1700	0.18	42	1.28
2	8.9	710	3200	1300	1420	4500	0.34	50	0.4
10	7.6	220	900	160	268	610	0.12	25	5.3
21	9.4	1600	3600	610	1920	5800	0.66	225	0.51
22	8.9	420	1000	400	670	2500	0.04	61	2.4
23	10.5	600	2000	600	570	3500	0.04	53	1.35
AVERAGE	8.7	667	2000	660	880	3102	0.23	76	1.87

TABLE 5. ANALYTICAL RESULTS FOR GLUE SPREADER WASH WATER

7	10.5	180	5100	42	2530	7500	2.6	Non Detectable	3.2
18	10.5	90	3000	2100	566	2200	0.17	2.7	13.5
AVERAGE	10.5	135	4050	1071	1548	4850	1.4	1.4	8.4

TABLE 6. ANALYTICAL RESULTS FOR DRYER FLOOR WATER

26A	4.3	380	170	38	104	280	0.11	5.2	17
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TABLE 7. ANALYTICAL RESULTS FOR LOG FLUME WATER

26B	4.6	780	2000	63	542	3500	0.76	2.3	22.3
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* Results reported as an Average

TABLE 8. GENERAL WASTEWATER RELATED INFORMATION

Plant	Wastewater Source	Volume	Disposal Method
1	6 steam conditioners	N/A	pipd to burner and burned
	1 dryer	N/A	floor cooling and clean-up water discharged to ground system which which overflows to a lake
2	8 hot water spray conditioners	N/A	water is recycled and discharged every 6 months to a swamp near a river
	2 dryers	500-1000 gal once a wk	clean-up water discharged to a swamp once a week
3	8 hot water spray conditioners	10,000 gal every 2 wk	recycled and discharged to biological treatment system and then to ground
	2 dryers-clean-up	2000-3000 per wk	treated as above
	-floor water	N/A	discharged directly to lake
4	10 steam conditioners	15,000 gal per day	continuously discharged to bio-treatment system and then to ground
	3 dryers	N/A	clean-up water pumped to deluge water holding lagoon
5	8 hot water spray conditioners	2000 gal not discharged	water is evaporated and the sludge is burned
6	3 hot water immersion conditioners	75,000 gal not discharged	recycled - never discharged
	2 dryers	N/A	clean-up water recycled as make up water for glue

TABLE 8. (CONT'D)

Plant	Wastewater Source	Volume	Disposal Method
7	8 hot water spray conditioners	5000 gal	recycled and discharged to ground once a week
	3 dryers	N/A	clean-up water discharged to ground once a week
	glue spreaders wash water	1000 gal - 3 times/yr	glue spreader wash water holding tank discharged to ground three times a year
8	8 hot water spray conditioners	16,000 gal	recycled - discharged to ground three times a year
9	5 steam conditioning chests	7000 gal/day	discharged continuously to municipal sewer
10	7 hot water conditioners	8000 gal every 6 wk	recycled and discharged to ground every 6 weeks
	3 dryers	N/A	only one dryer is cleaned with water the other two are dry-cleaned dryer floor water and cleanout water discharged to ground
11	10 combination steam and hot water conditioners	2,500 gal/wk	recycled and discharged to ground once a week (steam used only occasionally)
12	16 hot water conditioners	26,000 gal/wk	recycled and discharged once a week to ground
	2 dryers (clean-up and floor water)	N/A	discharged to ground (clean-up water, once a week floor water continuously)
13	8 steam conditioners	1800 gal/wk	continuously piped to burner

TABLE 8. (CONT'D)

Plant	Wastewater Source	Volume	Disposal Method
14	13 steam conditioners	7200 gal/day	continuously discharged to log sorting lagoons
	3 dryers		discharged once a week to log sorting lagoons
15	16 hot water conditioners	20,000 gal/wk	water is recycled and discharged to holding tanks. contents of tanks are pumped to burner once a week
16	13 steam conditioners	36,000 gal/day	discharged to two holding ponds in series. water from the second pond is either recycled as dryer deluge water or floor water or exfiltrates
	2 dryers-clean-up water -floor water	21,000 gal/wk	
17	16 hot water conditioners	10,000 gal	recycled and never discharged. during sump clean-up water is evaporated and sludge is burned
18	3 dryers clean-up water	6000 gal/wk	clean-up water and floor water discharged to municipal sewer
	4 glue spreaders wash water	up to 6000 gal/day	discharged daily to municipal sewer
19	1 dryer clean-up water	5000 gal/wk	combined with cooling water and discharged to a lake once a week
	floor water	200-300 gal/day	discharged to a lake continuously
20	3 dryers clean-up water		discharged to the sea once a week
21	5 dryers clean-up and floor water	50,000 gal/wk	discharged to ground or to the sea (more than one point of discharge)

TABLE 8. (CONT'D)

Plant	Wastewater Source	Volume	Disposal Method
22	7 dryers clean-up water	50,000 gal/wk	discharged once a week to a river
	floor water	N/A	discharged continuously to a river

23	2 dryers clean-up water	N/A	discharged once a week to a municipal sewer

24	5 dryers clean-up water	N/A	discharged once a week to a municipal sewer
	floor water		discharged continuously to a municipal sewer

25	7 dryers clean-up water	N/A	one dryer is cleaned every operat- ing day and wastewater is discharged to a municipal sewer with other waste

26	4 dryers	N/A	discharged once a week to a municipal sewer
	- clean-up water - floor water - log flume water		discharged continuously to a municipal sewer screened and discharged to river twice a year

27	5 dryers - clean-up water	N/A	discharged once a week to a river

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